Project title

Feasibility of collecting biomechanical data in a clinical setting for pressure ulcer prevention

Supervisors

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Project description:

Clinical motivation and rationale: Prevention of Deep Soft Tissue Injury in healthcare currently relies on labor-intensive vigilance. In many hospitals and community settings individualized prevention plan are developed. However, such individualized prevention strategies are limited by the extremely large range of descriptors and the complex interplay between them. Despite extensive literature on the etiology, prevalence figures remain high (18% on average in Europe (Vanderwee et al. 2007 https://onlinelibrary.wiley.com/doi/10.1111/j.1365-2753.2006.00684.x)). Emerging technologies that could be used to quantify risk factors of PUs are currently being developed in different scientific communities, typically in separate research tracks. These new technologies have the potential to transform the way we assess individual risks in hospital and community settings.

Biomechanical indices have been shown to be correlated to the injury risk in animal models. Such indicators potentially could contribute to the decision-making process. Several computational models of load-bearing soft tissue have been reported in the literature. However, the mechanical response predicted by such models have been shown to be very sensitive to the input data (geometry (Moerman et al. 2017 https://doi.org/10.1080/10255842.2016.1250259.), material properties (Luboz et al. 2014 https://doi.org/10.1016/j.jbiomech.2014.05.004.) and boundary conditions). Building patient-specific mechanical models for the prediction of strain localization is a long and tedious task but seems necessary to accurately evaluate the risk factors. To bring the research findings to the clinical environment, an accessible minimally time-consuming techniques should be employed.

Project objective: This research project aims to explore experimentally, in a clinical setting, the feasibility of collecting biomechanical and environmental and patient data to feed and to evaluate Finite Element models in a population at risk.

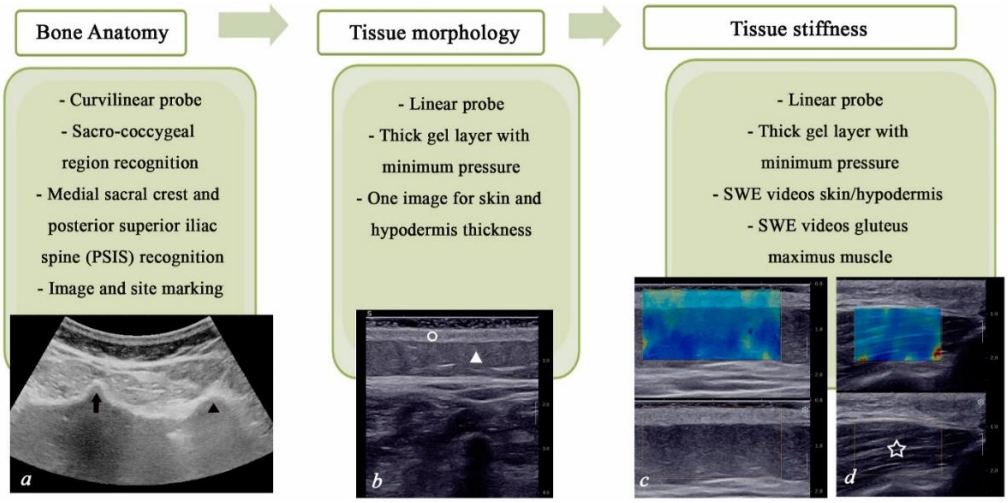

Figure 1. Adapted from the previous study of (Maher et al., 2022, https://doi.org/10.1016/j.jtv.2022.02.003). US acquisition protocol of the sacral region in the transverse view. In B-mode: the medial sacral crest (arrow) at the level of the PSIS (black triangle) (a), skin (arrow) and adipose tissue (white triangle) over MSC (b); in SWE mode: the skin and adipose tissue (c), gluteus maximus muscle (star) (d).

Work program: The project will be divided into two main parts

1. The first step will consist in making an inventory of all the data to be collected in the different services concerning the prevention, detection and care of pressure injuries. The idea is to create a medical database and to work with the IT department of the Fondation Hopale to define the online forms necessary to collect data that have not yet been collected in a structured way. The student will also work closely with caregivers to define where, when and how to collect this data. For data that is already captured in a structured way, it will be necessary to identify them and work with the IT department to extract it. The outcome of this section is to set up a tool to collect environmental and patient data.

2. The second step will focus on the assement of biomechanical parameters. This step will require the definition of specific methods allowing the risk assessment in conditions as close as possible to the clinical routine and with a reduced time to invest by the subject. Preliminary work has been initiated for the characterization of geometry (ultrasound imaging) (Abou Karam et al., https://doi.org/10.1016/j.jtv.2022.02.003; Doridam et al., https://doi.org/10.1016/j.jtv.2018.08.002), material properties (Shear Wave Elastography, US-based indentation) (Fougeron et al., https://doi.org/10.1115/1.4046444), boundary conditions (pressure distribution, posture) (macron et al., https://doi.org/10.1016/j.jbiomech.2018.08.001). However, the definition, evaluation, and implementation of the different characterization methods still remains largely to be investigated and is the major challenge of this work.

The first step will consist in writing the protocol, Applying for approval and authorization of the French Ethics (Loi Jardé (Ordonnance n° 2016-800 of 16/06/2016)). Data will be collected from 2 groups of patients paired in terms of BMI and sex-ratio: 1/ at-risk old persons (SCI persons coming for positioning interview and braden scale lower than 12) N=30 and 2/ general population (young healthy volonteers) N=15. The following quantities will be collected (figure 1) : Pressure distribution, B-mode ultrasound imaging : bone geometry, tissue morphology, Shear Wave imaging, Posture